CHEC – a Compact High Energy Camera for CTA

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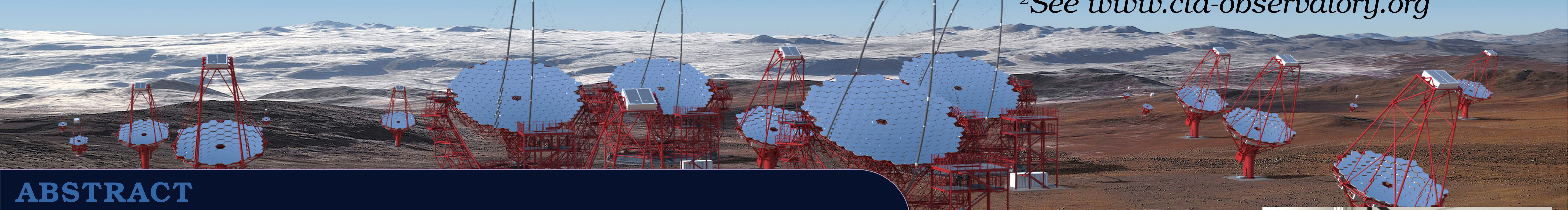
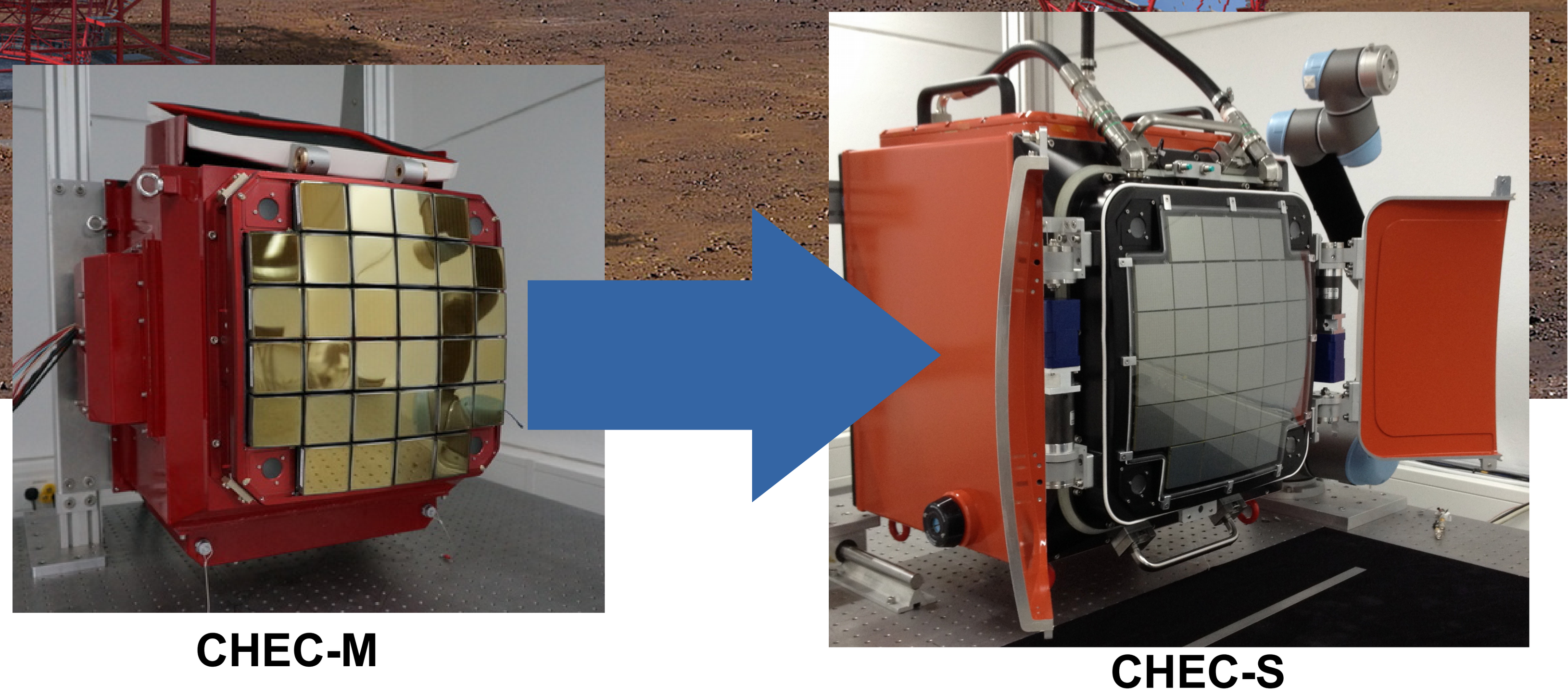
cherenkov telescope array



ABSTRACT

The Compact High-Energy Camera (CHEC) is a design option for the Small-Sized Telescopes of CTA, focusing on cosmic gamma-ray detection at energies from 1 TeV up to around 300 TeV using atmospheric Cherenkov light. The use of dual-mirror, Schwarzschild-Couder (SC) optics allows CHEC to be very compact (~0.5 m diameter) and low-cost (~150 k€), containing 2048 pixels with a physical size of 6x6 mm^2 leading to a field of view of over 8°. Electronics based on TARGET Application-Specific Integrated Circuits (ASICs) and FPGAs allow a flexible trigger scheme and continuous sampling at 1 GSa/s. Full waveforms for every pixel are read out without loss at over 600 Hz. Two full cameras prototypes are developed. The first, based on multi-anode photomultipliers (MAPMs) as photosensors, was successfully characterised in the laboratory and during two measurement campaigns on a telescope structure at the Paris Observatory in Meudon where it saw first Cherenkov light from air showers. The second, featuring upgraded electronics and Silicon photomultipliers (SiPMs) improving the overall performance, is under commissioning at the Max-Planck-Institut für Kernphysik in Heidelberg.

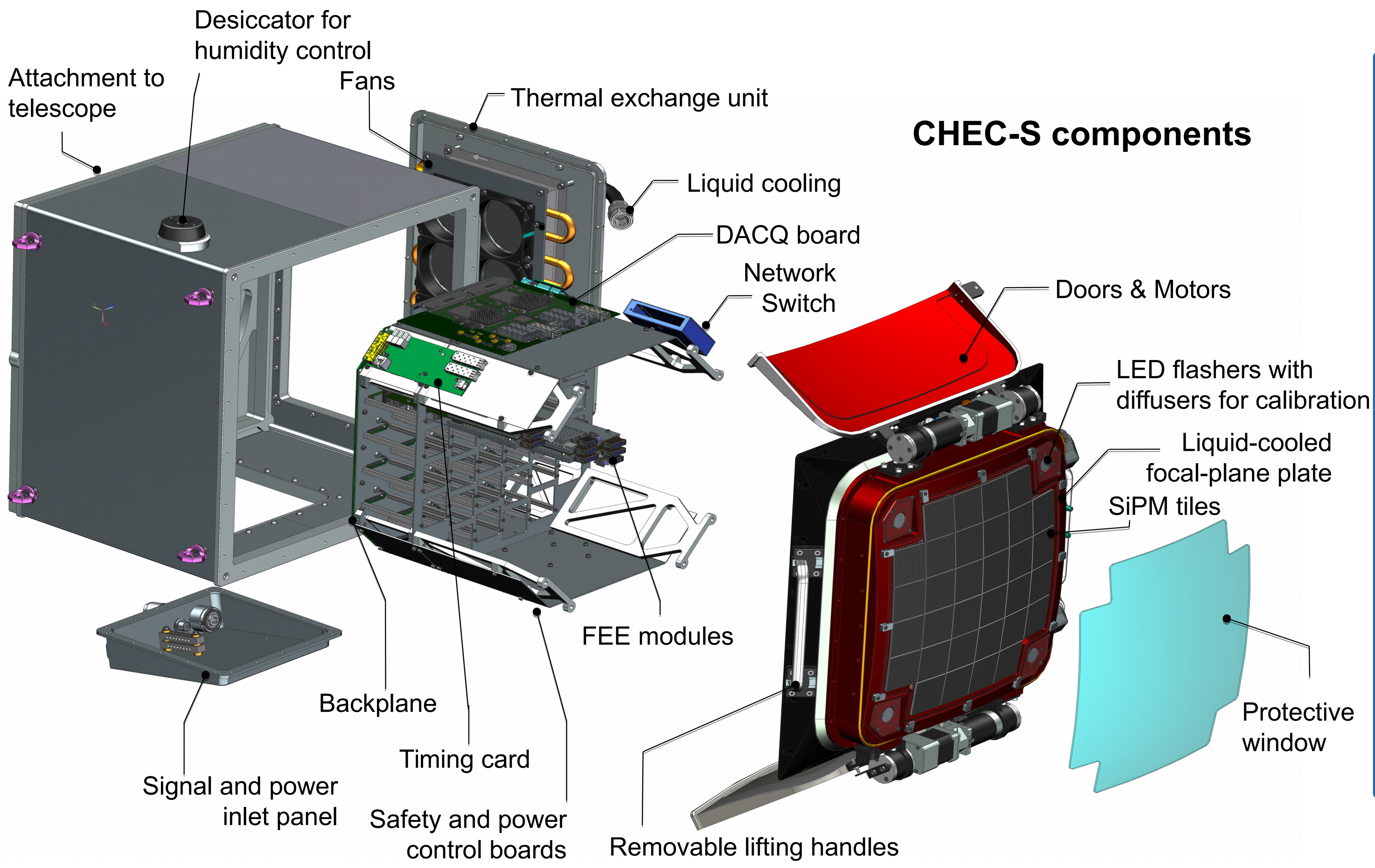


CHEC-M

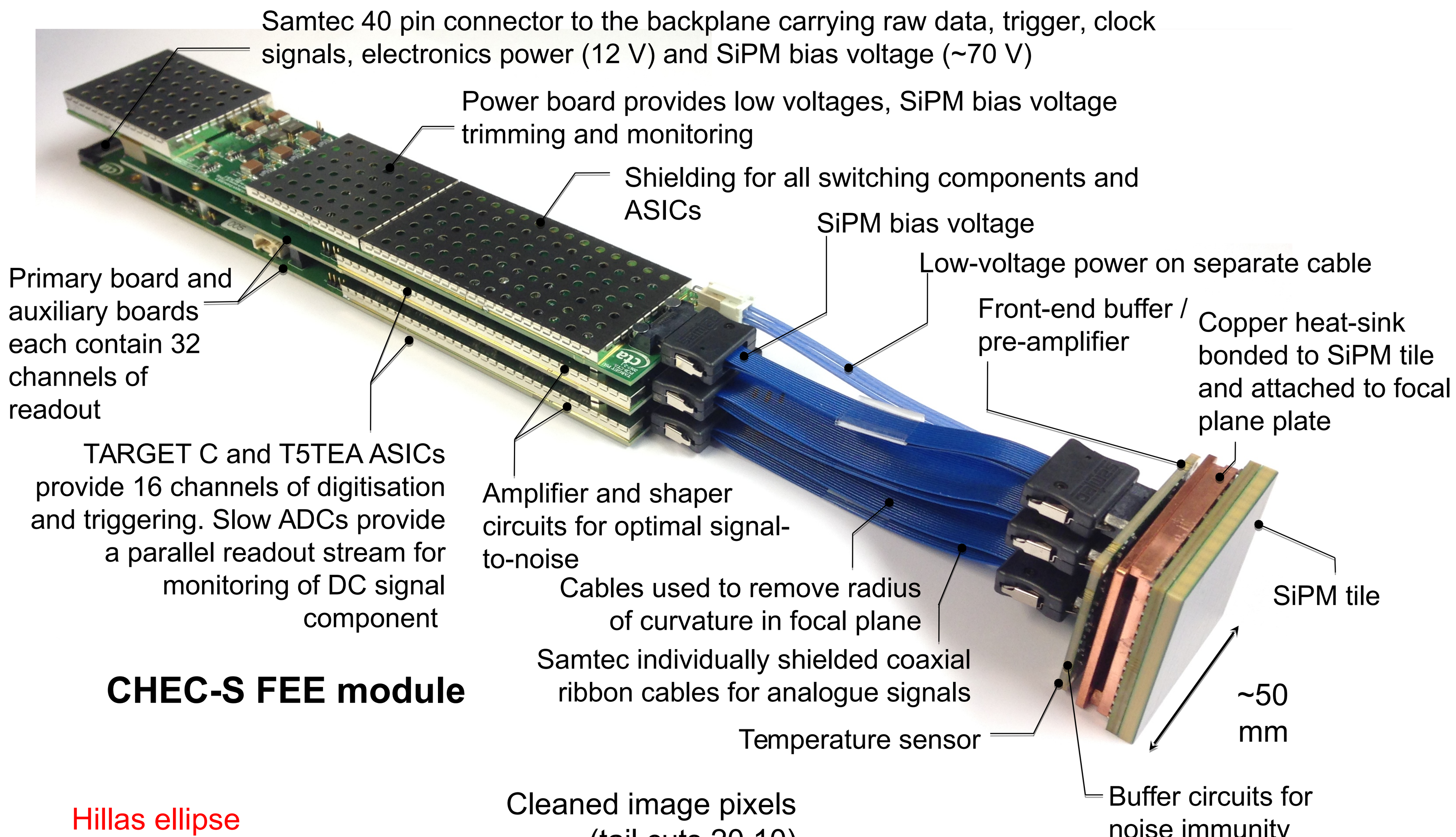
CHEC-S

DESIGN

- **2 full camera prototypes:**
  - CHEC-M using Hamamatsu H10966B MAPMs
  - CHEC-S using Hamamatsu S12642-1616PA-50 SiPMs
  - Very compact: ~0.5 m diameter
  - SC design → curved focal plane
  - 32 photosensors
    - each with 64 pixels of size: ~0.15°
- **Front-End Electronics (FEEs):**
  - Based on TARGET ASICs
  - Continuous sampling & digitisation at 1 GSa/s
  - 1st level triggering: analogue sum of 4 neighbouring pixels
- **Back-End Electronics (BEEs):**
  - 2nd level triggering:
    - Flexible trigger pattern scheme
    - Time coincidence of 1st level triggers from FEEs
  - Full waveform readout of all 2048 pixels via fibre-optic link at up to ~1 kHz



CHEC-S components



CHEC-S FEE module

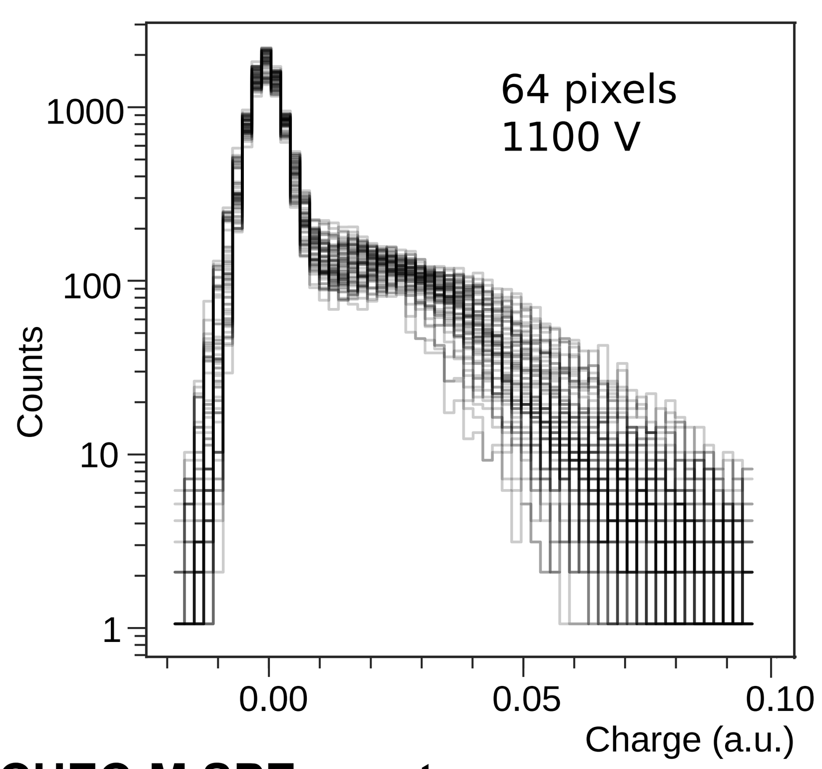
PROTOTYPING

CHEC-M:

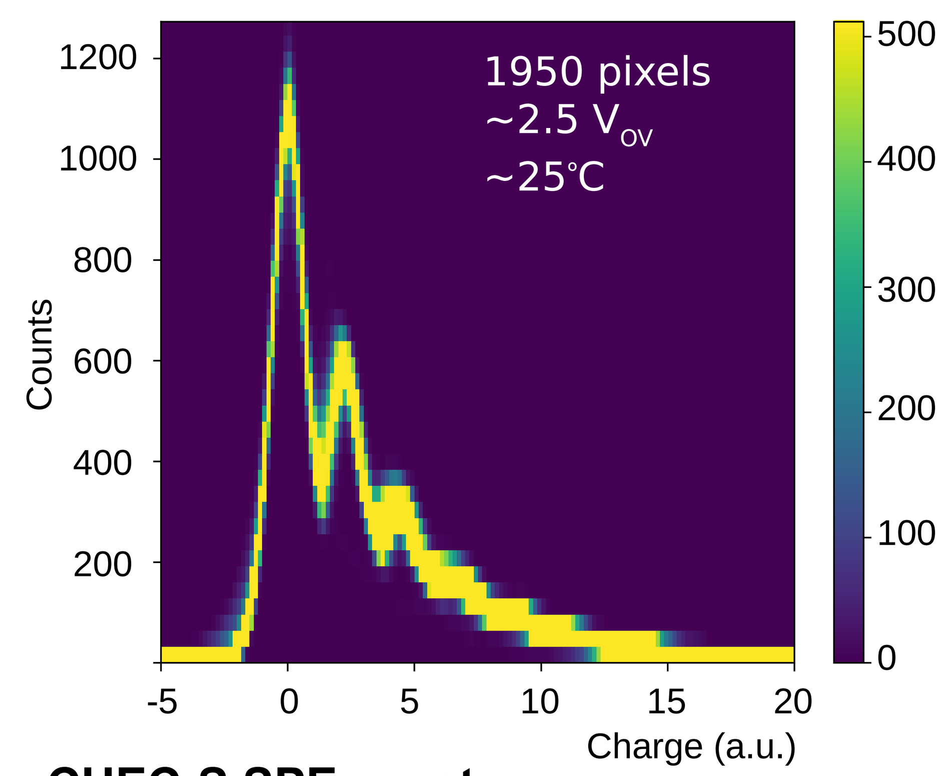
- Fully characterised & tested
- First Cherenkov light in Nov 2015 as
  - *first* CTA camera prototype
  - *first* camera based on SC optics
- Cherenkov events' analysis making use of full waveform readout:
  - Time propagation of Cherenkov images across focal plane
  - Useful for advanced analysis

CHEC-S:

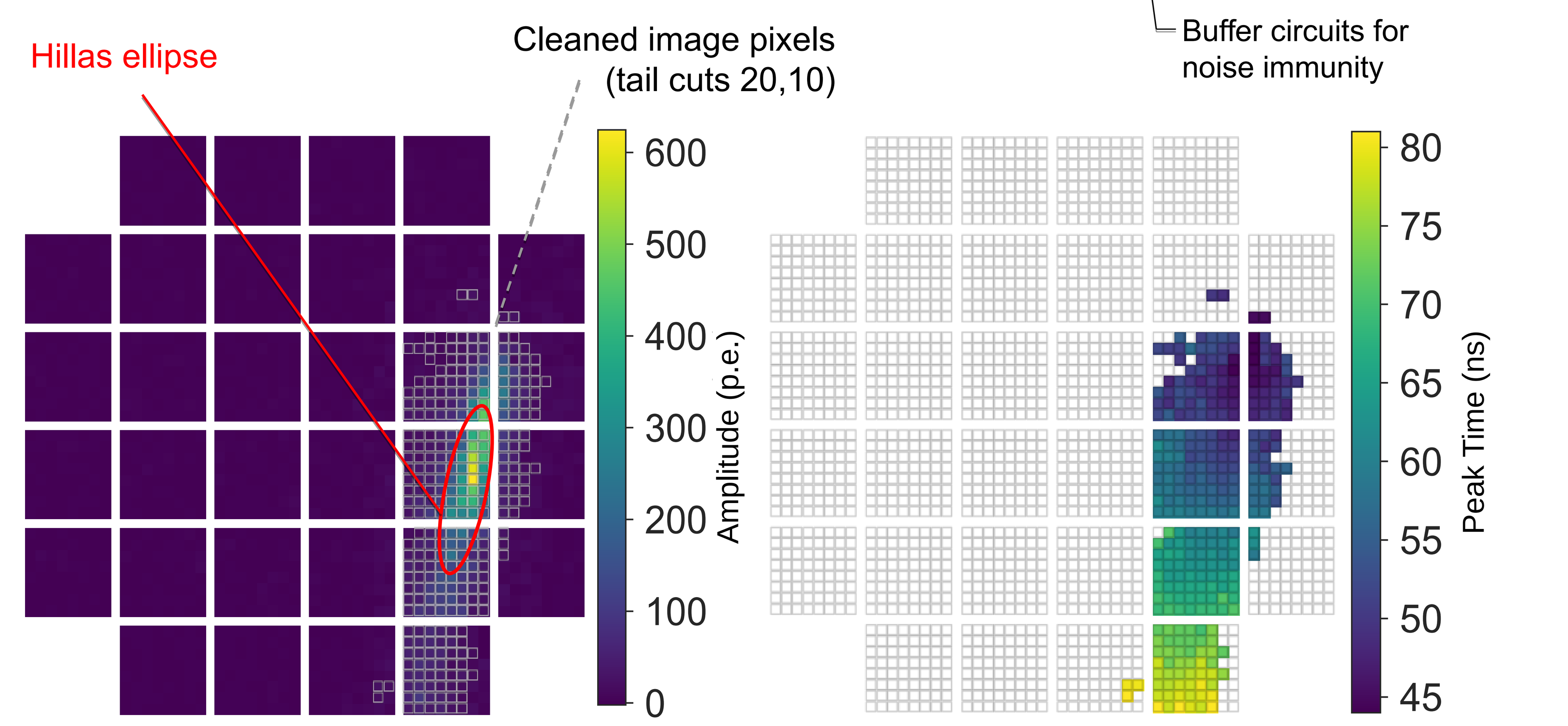
- Currently commissioned & tested
- Improved performances:
  - Gain determination easier using single photoelectron (SPE) spectra (even with dark counts)
  - Lower gain spread
  - Higher photon detection efficiency
  - Observation at higher night-sky brightnesses
  - Better trigger performance
  - Increased charge resolution
  - Dead-time free up to ~1 kHz



CHEC-M SPE spectrum



CHEC-S SPE spectrum



CHEC-M Cherenkov images (amplitude & peak time) for a same event

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